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Early Specialization

A Limiting Factor for Long Term Development of Korean Athletics

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Abstract

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The aim of this research was to assess the efficiency and effectiveness of Korea's sport talent development system in accomplishing its intended goals.

As first step for this assessment, theoretical framework of the research was formed by identifying common characteristics evident in western literature on specialization, and relevant law and literature on sport talent development system of Korea. The established theoretical framework posited that early specialization of early talents are necessary components of

producing eventual high performing (internationally competitive) athletes, in the Korean Model for Sport Talent Development.

Next, a sport perceived to be under-performing despite extensive and continued support granted by government agencies and conglomerates in Korea, the sport of athletics, was chosen as subject sport of research.

The research questions formulated were as follows:

- RQ 1. Are early talent and early specialization in athletics prerequisites for eventual top performance in the same sport?
- RQ 2. What are the characteristics of eventual top performers in athletics?

Research method involved a quantitative analysis of Korean athletics by incorporating reliable athletes' performance data available at the national governing body of the sport, Korea Association of Athletics Federations, data recalled (via web-based survey) from the memory of subject athletes, and other reliable published resource (i.e. from International Association of Athletics Federations).

Specifically, by cross-referencing the Top 100 Lists of sprint events (Men's 100m, 200m, 400m, and Women's 100m, 200m, 400m), 399 subjects of survey were identified. With 73.68% response rate to web-based surveys, and exclusion of 4 respondents whose performance(result) was

beyond the scope of reference data for dependent variable, 290 athletes resultantly became the sample population for quantitative analysis.

Major statistical analysis involved was a correlational analysis conducted in an attempt to answer RQ1., and linear multiple regressions for RQ2 ; and in relevance to the results of analyses further descriptive statistics were presented on certain variables.

Results revealed, firstly, not only that there wasn't any significant correlation between 'early talent and early specialized' athletes and their eventual performance, but also an inverse correlation was found in men's case. Secondly, successful athletes started athletics specialization later than it is presumed in the Korean Model of Sport Development. Furthermore, whereas sampling variable(prior sport participation) had no significant relationship with eventual performance in women's case, positive relationship was found in men's case. Thirdly, the results seem to hint that some of the institutional tools put in place by Korea's sport policy to encourage elite athlete development, were being exploited to attain the benefits rather than functioning as stepping stones to produce high level athletes. In men's case especially, there wasn't any significant relationship between the motivation for military service exemption benefit and later performance, but a negative relationship was found between the motivation

to advance to higher education through sporting achievements and eventual performance.

Results of this research negate the presumptions inherent in the Korean Model of Sport Talent Development, which posits early identification of talent and early specialization as key and necessary requirements in reaching eventual high performance. Therefore, beyond the generalized approach of Korea's sport talent development system, it calls for implementation of a more differentiated, sport-specific model to elite sport development in Korea.

Keywords : Sport Specialization, Early Specialization, Long-term Athlete Development, Student-Athlete, Elite Sport System, Korean Athletics, Sport Talent Development

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Chapter 1. Introduction

1.1. Current Context

The current sport policy of Korea, Sport Vision 2030, promulgated by the Ministry of Culture, Sports and Tourism is an attempt to compensate for what had been sacrificed throughout its modern sport history. Promoting sports for the public or “Sport-for-all” is at the core of this vision, which aims to establish a foundational basis of sport by supporting and popularizing sports clubs at non-elite level. At the same time, recognizing the national value of maintaining high performance at international level, the vision also acknowledges to maintain the backbone of the former elite sport system, and envision that building a foundational basis of sport (through sport-for-all) will not only benefit the general public, but also provide more robust and sustainable flow and identification of elite athletes.

Ideally what this will also reinforce is a synergetic exchange between elite and sport-for-all sectors, i.e. coaches who have extensive experience in training elite athletes will transfer their expertise and knowledge to non-elite population at sports clubs.

However, the pillars of elite and sport-for-all in operational context remain separated. Cross-over of athletes from one to another is prohibited,

namely to protect the interests of voluntary participants in sport-for-all sector (sport clubs) from specialized talents in elite sector, meaning those granted the status of “athletes”(or “student-athletes”) by registering with the national governing body of respective sport cannot participate in sport club competitions for non-athletes, or vice versa.

Whether this separation stays or gradually merges with one another is to be seen. This transitional phase, however, is an important and valid juncture where a practical assessment of former elite sport system ought to be conducted so that areas of improvement for future renovation of the system can be identified and applied so that it becomes more efficient and effective in the stages of bringing up elite athletes of national value.

1.1.1. Korean Athletics

Having the recognition of a foundation sport along with swimming and gymnastics, Korean Athletics, and especially its governing body, has enjoyed extensive and continued governmental support as well as financial sponsorship and managerial engagement of conglomerates such as KEPCO and Samsung over the past decades. Yet its continued under-performance has caused concerns for many stakeholders and sport researchers in the academic field.

Studies on Korean Athletics centre around investigation of its policy and making suggestions on further investments. For example, Lee Yong-Sik(2008) analysed current status and issues of Korean Athletics and proposed policy alternatives for its development ranging from short-term measures to enhance the level of athletics performance in preparation for 2011 Daegu World Championships in Athletics, to long-term measures such as improving attractiveness of the sport, increasing membership numbers and expanding facility infrastructure, and substantializing the international status of the sport by producing IAAF level officials and driving strategic exchange programs with other countries, etc. Kim Kyung-Un et al(2009) on the other hand, employed a normative Sport Development model to assess the process of athlete development in Korean Track and Field and investigated the significance at individual and socio-environmental level.

No research, however, has yet attempted at a quantitative level to validate the efficiency and effectiveness of the (talent development) system that surrounds, and has been embedded with Korean Athletics, in terms of producing its intended goals (high performance and medals at global sporting stage).

1.2. Scope and Outline

In Chapter 2, an analysis of Korea's sport talent development system will be conducted and compared with known characteristics of Standard Model of Talent Development and specialization in Western literature to demonstrate that Korea's elite sport system opens the door for "early and single specialization" of "early talents," and continued accumulation of practice(specialization) to reach expert and eminent performance status.

In Chapter 3, a theoretical framework (Understanding Korean Model of Sport Talent Development through the lens of SMTD and Specialization) will be established based on the review from the previous chapter. Subject sport discipline and events of research will also be identified, and justification presented for the formulated research questions.

Chapter 4 will first outline the overview of research methods, and explain and set out the parameters of research. Research will not only use reliable and available athletes' data, but also incorporate data recalled from the memory of subject athletes, which will be collected through web-based surveys.

Chapter 5 will present and interpret the results and findings, and Chapter 6 discussion and limitations.

1.3. Research Significance

In order to serve the purpose and validity of the research, a sport perceived to have been relatively under-performing in terms of international competitiveness, Korean “athletics”, will be chosen as the main subject of this research.

Employing a quantitative approach and analysis for a specific sport will add a new dimension to the literature on Korean sports, where most studies in the vein have used qualitative methods.

Moreover, whereas studies on Korean athletics have made extensive suggestions on areas of improvement for the sport implicitly presuming and supporting the effectiveness of current system (including recommendations to further strengthen and reinforce the current structure), this research will attempt to verify such presumption.

In summary, the significance of this research will be the following:

- Assessing the efficiency and effectiveness of the Korean Model of Sport Talent Development at a quantitative level on a specific sport may pave a path for a new dimension where other sports in similar settings, not limited to Korea, may be investigated.
- Similarly, the theoretical framework built for the purposes of this research may be applied and expanded to other sports.
- Korea’s sport system will be analysed incorporating theories of

specialization and SMTD, and thus the study will add to inter-disciplinary bridge between two fields of study (sport policy/system and sport specialization)

- The research findings may be able to suggest an area of improvement in the current system (of Korean sport), for the subject sport discipline of this research ("athletics")
- It may also provide a direction for future comparative study with sport structures in other sport-advanced countries.

Chapter 2. Literature Review

To conduct a thorough analysis of Korea's elite sport system and its talent development model, we will first review western literature dealing with Standard Model of Talent Development and Sport Specialization. This will be followed by an analysis of known characteristics of Korea's sport system with evidences present in literature and sport policy and law of the country. In the following chapter, a theoretical framework of this research will be established based on common features identified through this analysis, and research questions will be proposed.

2.1. Standard Model of Talent Development (SMTD)

Bailey and Collins (2013) have argued that there exists what they call a 'Standard Model of Talent Development (SMTD)', which operates with a broad base of mass participation at the lowest level, and successively involves fewer and fewer players with progression to higher levels. The defining logic of this model is well represented by 'The pyramid of sports development' (Figure 1).

Houlihan(2000) and Kirk et al.(2005) have also pointed out that many sports development policies incorporate different versions of this

pyramid model, and that its influence is observed in many international sports participation models.

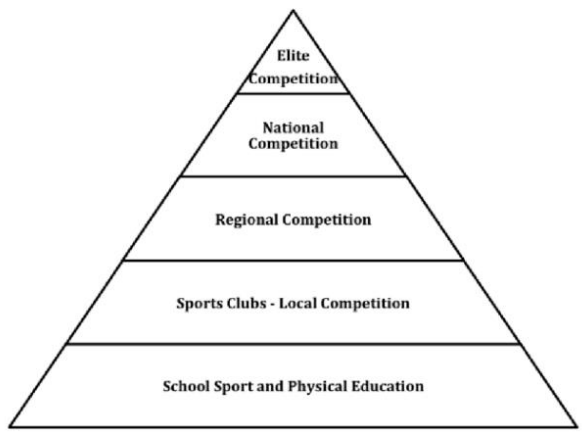

Figure 1. The pyramid model of sports development
(Bailey and Collins. 2015, adapted from Tinning, Kirk & Evans. 1993)

Bailey and Collins(2015) emphasize that in SMTD focus is on early ability and early specialization of athletes, which are presumed to be necessary components of athlete's later success, and the possibility that others may meet the necessary standards (to join the talent route) later is ruled out.

2.2. Sports Specialization

2.2.1. Existing Definition of Sports Specialization in Literature

Sports specialization is defined as "year-round training (greater than

8 months per year), choosing a single main sport, and/or quitting all other sports to focus on 1 sport." (Jayanthi et al., 2013, Malina RM, 2010, Jayanthi et al., 2015, Gregory D. et al., 2015).

AOSSM Early Sport Specialization Consensus Statement (2016) added 'involvement of prepubertal children' to above definition to further define early specialization.(LaPrade, R. F et al. 2016)

2.2.2. Early Specialization

The idea of early specialization in sport roots mainly from Ericsson et al. (1993)'s theory on deliberate practice. They argued that deliberate practice is a highly structured effortful practice that lacks inherent enjoyment, and one that is conducted with the explicit purpose of improving current level of performance. With evidence from their study on expert musicians, they reasoned since accumulation of deliberate practice(specialized training) is key to eventual level of performance, beginning specialized training characterized as deliberate practice as early as possible, so as to acquire most hours of practice (i.e. at least 10 years), increases the chance of achieving eminence in their chosen domain. It was also asserted that this accumulation of deliberate practice must begin before puberty, within the critical periods of one's biological and cognitive development.

2.2.3. Doubts on early specialization in sport.

Doubts and criticism rose against Ericsson et al. (1993) approach on development of sport expertise in various aspects. First of all, Van Rossum(2000) found that the elite performers failed accumulate the golden rule of 10,000 hours of specialized training. Also, consensus could not be reached due to lack of evidence to support the presumption that early specialization and higher amount of specialized training are related to greater success (Carlson, 1988; Barynina & Vaitsekhovskii, 1992; Lidor & Lavyan, 2002, Vaeyens et al., 2009). Furthermore, Baker and Côté (2006) cast concerns that focusing solely on deliberate practice overlooks other important factors (developmental, psychosocial, motivational) relevant to athlete's development.

2.2.4. Early diversification(sampling), and late specialization.

As an alternative to the theory of early specialization, Côté et al., (2007) came up with the concept of early diversification(sampling) and proposed 'Developmental Model of Sport Participation (DMSP),' which incorporates the window of sampling years prior to the stage of specialization (with more emphasis on deliberate practice). The theory posits that participation in different sports could prepare the young athlete

with important abilities that will be conducive to developing sport-specific skills required to achieve eminent performance later in the main sport later. This view of skill transfer across sports has been supported by a number of scholars in the field (William & Ford, 2008, Baker, et al., 2003, Schmidt & Wrisberg, 2000). The idea of sampling has also been confirmed and supported by studies that found higher percentage of elite athletes participated in more than one sport in early stages of sport career than near-elite athletes (Lidor and Lavyan, 2002), and in internationally competitive German athletes, specializing in one sport prior to engagement in the main sport was more prevalent (Emrich and Güllich, 2006)

The theory of DMSP also hypothesizes that diversifying early sporting activities with the concept of deliberate play (as compared to deliberate practice), promotes development of intrinsic motivation (that is lacking in deliberate practice), which will function as self-motivation for prolonged involvement in the sport and lower frequency of drop out (Côté et al., 2007, 2009, Baker & Côté 2006).

Some evidence has also suggested that late specialization can be more beneficial for becoming a high level athlete. Studies have revealed that successful elite athletes specialized later than their less successful peers, but nevertheless and despite the late start were also found to have compiled

more training hours than their peers by the time they reached peak performance (Carlson, 1988, Barynina & Vaitsekhovskii, 1992, Lidor & Lavyan, 2002, Emrich and Güllich, 2006, K. Moesch et al., 2011). Study of K. Moesch et al. (2011) specifically found that late specialization is more beneficial in cgs sports (sports measured in centimetres, grams, or seconds), however, his results did not confirm the proposed benefits of early diversification.

2.3. Long Term Athlete Development (Istvan Balyi)

With the theory of specialization and scientific research in mind, Istvan Balyi et al. have proposed more clear distinctions between early specialization and late specialization (Balyi, 1999, 2001, Balyi and Hamilton, 1999, 2004).

2.3.1. Early Specialization and Late Specialization Models

Early Specialization Model	Late Specialization Model
1. Training to Train stage	1. FUNdamental stage
2. Training to Compete	2. Learning to Train
3. Training to Win	3. Training to Train
4. Retirement / retainment	4. Training to Compete
	5. Training to Win
	6. Retirement / retainment

Figure 2. Specialization Models (Balyi and Hamilton, 2004)

As seen in Figure 2, a four-stage model for early specialization

sports, and six-stage model for late specialization sports are proposed. The main difference between the two models is that whereas early specialization sports require early sport-specific training, late specialization sports need a more generalized approach to early stage of training (hence the addition of fundamental stage and learning to train stage).

The study(Balyi and Hamilton, 2004), however focuses on detailed stages of late specialization(i.e. athletics) sports referring to the fact there are only a few early specialization sports (i.e. gymnastics, rhythmic gymnastics, figure skating, diving and table tennis)[1] corresponding to the four-stage model.

2.3.1.1.Six-Stage Model for Late Specialization Model

According to Balyi's model for late specialization, the first two stages relate to learning all fundamental movement skills and sports skills. He designates a window of opportunity (age 8-11 for females, and 9-12 for males), when these skills must be developed to build the "cornerstone" ability of athletes to reach their full potential. He emphasizes that bypassing these two stages and jumping to higher stages, in other words specializing

[1] This notion is supported by studies of Bompa(1995, 1996), Drabic J(1996), Hartley G(1988), Rost K, Schon R.(1997)

early in late specialization sports, can be detrimental to the following stages of skill development.

Building the “engine” and consolidating sport specific skills should only begin in stage three (Training to Training Stage), which he defines as between the ages of 12–16 and 11-15 for males and females respectively.

It is important to note that the chronological age he proposes are generic based on reference points such as the average age for Peak Height Velocity (PHV), which is noted as important periods of trainability. What he emphasizes here is that individual athlete’s biological age should be the basis for identifying which stage of the model be implemented for the concerned athlete.

2.4. Historical Background on Korea’s Sport Development

The way of Korean government’s involvement with or utilization of sport has been the major driving force of sport development in Korea, and this is well observed and presented in literature dealing with history and policy of Korean sports. In large Korean sports has undergone a unique history of its own, transforming itself into an unprecedented form as it exists today.

Lim and Lee (1995) labelled the years leading up to early 1980s as “non-policy years” on sport in Korea. This stage encompasses the era of

Japanese occupation of the country, the subsequent years that saw brief liberation of the nation, followed by Korean War, separation of two Koreas on the peninsula, and eventually the initial years of re-building and stabilizing the country. In these years, there was no room for government or nation to take keen and systemic interest in sport. Therefore, sport policy during this period involved only those sport disciplines such as athletics and gymnastics that did not require substantial financial support. However, leading up to the end of Park Junghee's regime, improvements in economic situations helped garner interest in sports. (Lim and Lee 1995).

Embarking on the 5th Republic, sport takes up the forefront of governmental policies. The 1986 Seoul Asian Games and 1988 Seoul Olympic Games were held in this period. Lim and Lee (1995) point to political and economic factors that attributed to the hosting of mega-sports events. On the economic side, the country began to make trade surplus by 1986, which invigorated the economy. This also meant looking for ways to spend idle money, where sport received key attention. On the political side, the incumbent regime had taken over the government by military coup and was therefore facing public resistance due to lack of governmental legitimacy. Here, sport was again an efficient tool to turn public attention away from politics.

In similar vein, Bae (2013) argues that the government has established direction of the sport (with sport policy) and engrafted it into the aspects of society. He asserts that “Nationalism” and “Statism” is confirmed in Korea, who saw its social development with government as central force.

The connection of sport with political situation of the country has also been explicitly demonstrated on many occasions at global sporting stages. The first unitary inter-Korean team was formed in 1991 World Table Tennis Championships. Ignited by this first unified appearance, the two Koreas entered the opening ceremony together holding out a common flag at 2000 Sydney Olympic Games, 2002 Busan Asian Games, 2004 Athens Olympic Games, 2006 Torino Winter Olympic Games (and 2018 Pyeongchang Olympic Games). At times of political and military conflicts between the two Koreas, such sports exchange did not materialize. (Bae, 2013)

While it is evident that government has used sports as a socio-political means to maintain its regime, integrate society, and boost and raise national morale and glory by way of hosting mega sports events and launching professional sports, development of sports was also directed towards the same goals. Predominant focus of the government has been given and granted to elite sport development, while neglecting sport-for-all.

The pinnacle of this trend is so called a “government-led/managed student-athlete” policy, elite sport system and structure formulated by which has produced numerous side-effects ; research pointing out these problems, as well as follow up studies to come up with counter measures are abundant in literature(Shin Wook Kang, 1998; Jeong Myeong Kim, 1999; Chang Hoon Seong et al. 2001, Chang Hoon Seong 2002, Yang-Jong Kim, Goo-Young, Jung, 2002; Cheon Taik Son, 2004, Jong Su Baek, 2004; Tae Ho Yu 2005, Deock Ki Hong & Tae Ho Yu 2007, Kwnag-Min Cho 2007; Hyeong Seok Son, 2009; Tae Ryong Han, 2009; Hyuck Gi Lee, Soo Weon Lim, 2010; Young Kyun Shin, 2010; Eunchang Kwak et al, 2011; Hyuck Gi Lee, 2011; Soo Weon Lim, 2011; Yong Suk Yim et al., 2014). However, the core of the system is maintained, implicitly acknowledging that such sacrifices are for the greater good - uplifting national glory and integrating society.

Along this trend, the non-profit sport organizations have largely depended on government funding (along with financial and management support from conglomerate corporations for some) to develop their sport, meaning that they have not themselves had the time to reflect and evolve as to understand what may be the most constructive and efficient talent development pathway for their specific sport would be, but rather have reluctantly accepted the talent development structure proposed, supported,

and shaped by the government.

In terms of producing international-level athletes, most sports have benefited exponentially from this funding structure, putting Korea on the map of global sports on numerous occasions. Others who have not been able to perform against the expectations, have been frequent targets of media criticism. One of the foundation (so entitled) sports of Korea, athletics, has been no exception in this light.

2.5. Korea's Sport Talent Development System

Many factors have contributed to the formation of Korea's Elite Sport System, with government-led student-athlete policy being the major driving force. This was also augmented by establishment of national games structure, sport specialization schools, and separation of athletes with non-athletes by law on sports.

Following review will allow us to see how Korea's student-athlete policy has functioned as an enabler of identification and specialization of "talented" athletes, supported by Sport Promotion Act and School Sports Promotion Act that recognize student-athletes in isolation for participation in regional and national-level games and competitions for elite sport. On top of this, existence of earlier divisions (elementary 4^{th}-6^{th} graders for example) has helped to open the door for early identification and early

specialization of talents.

2.5.1. School Sports (athletic club) Policy

Whereas interscholastic sport in sport-developed countries is within the boundary of in-school physical activity that involves participation of students in a variety of sports clubs and competing against other schools, school athletic club (*Woon-dong-bu* in Korean; and not to be confused with "athletics" as athletic club can be of any sport) in Korea under the umbrella of government policy selects talented student-athletes and entitles them as "special sport talent", ranks them through interscholastic competition, and grants preferential rights in college admission and Korea's mandatory military service, with ultimate purpose of entering them at international level competitions in order to raise national morale. (Cho & Lee, 2013)

The problems of Korea's school sports system revealed through precedent studies are in essence the characteristics of the system. Kang (2003) argued that 'Korea's School Sports system though placed within the boundary of school education, was evolving into a bizarre form completely distant from the goal of whole-person education by the schools.

According to Ryu and Lee (2004) the negative aspects (characters) of the system are as follows:

- Emphasis on totalitarian management over individual approach

to athletes (violation of human rights)

- Emphasis on goal-oriented approach ('winning') over athletes' basic rights (right to be fit and healthy, right to receive proper education)
- Excessive training demands on athletes without consideration of their biological development
- Violent treatment from coaches or senior athletes in the event of low sport performance

2.5.2. Special Sport Talent System (or Athletes Admission and Scholarship Policy)

School Sport Enhancement Plan was declared on 5th October, 1972 as part of Sports Promotion Plan, and education enforcement ordinance enacted on 9th November of the subsequent year implemented the special sport talent system.

The main goal of this system was to give special rights to student-athletes an opportunity to advance to higher education depending on their sport performance regardless of their academic accomplishments. The special rights also included provision of school registration fee and exemption of tuition fees, and military service exemption system

incorporated in the subsequent year laid foundation for student athletes to continuously improve and maintain their athletic performance throughout all stages of education and even through military service years (for men). (Cho & Lee, 2013)

Utilization of special sport talent system by the government and attempts to alleviate its side effects with provision of counter measures throughout different government administrations (regimes) of Korea are well outlined in the article by Cho and Lee (2013, p4)

2.5.3. Lowest Grade of Academic Abilities Policy

Lowest grade of academic abilities policy was enacted as part of School Sports Promotion Act in 2011 with an aim to ensure student's right of learning.

Cho and Lee (2013) point out that the functions of this policy were to set minimum academic standards required to advance to university, as well as to issue sanctions for student-athletes (i.e. restricting participation in competitions) who do not meet the standards.

2.5.4. Sports Schools and Sports Promotion Act

2.5.4.1. Sports Specialization Schools

Sports Middle Schools and Sports High Schools begun to be

established at regional levels across Korea starting with Seoul in 1971 and Gyeonbuk province in 1972. These are specialty institutions built for the sole purpose of fostering student-athletes. Students enrolled in these schools are linked with student-athlete policy and are expected to advance to higher education (up to university level) depending on their sport performance and achievements at national-level championships and games. (2016 Sport White Paper – Korea)

2.5.4.2. School Sports Promotion Act and School Athletic Club (Woon-dong-bu)

Any of these Sports Schools have school athletic clubs in varying degrees, and any non-sports schools that wish to run school athletic clubs can operate them. However, what differentiates these clubs from sports clubs or school sports clubs in Europe or US is that being part of school athletic club(as opposed to school sports club) is strictly limited to those athletes registered with the governing association of the respective sport and granted the status of “athlete”, and therefore are recognized as student-athletes (by School Sports Promotion Act).

2.5.5. National Games/Competitions Structure

Whereas government-led student-athlete policy has paved the way

for specialization of talented student-athletes for the sole purpose of "winning", the existence and scope (divisions) of national competitions/games structure and sport specialization schools (and school athletic clubs) augmented this structure to stretch the door down to lower school grade students for early identification of talent and onset of specialization.

Korea's National Junior Athletic Competition (athletic here referring to sports) celebrated its 47th edition in 2018. It broke away from National Sports Games in 1972, to serve many purposes – to provide a platform of a whole-person education through sports, to promote sports to the youth, encourage sportsmanship, increase sports population and create foundational basis for sport-for-all, and "early" identify talented athletes in order to strengthen the country's international competitiveness in sport. (2016 Sport White Paper – Korea)

The definition of word "Junior" in the title is by no means similar to the concept used in western sport (i.e. 18 or 19 years of age), but allusion here is to young athletes from 4th grade elementary school students to 3rd grade middle school students with age range of 10 to 15 years old.

In 1970s, due to the issues of over-heated competition among cities and districts, athlete burnouts, class absence, career problems, many

counter-measures were implemented, but eventually the event was abolished in 1989. However, public opinion rose again with imminent demand for a competition to develop grassroots athletes and addressed the concerns for future of the country's sport, reviving the event in 1992 and leading to present date.

Although established with multi-purpose for developing sport in Korea, National Junior Sports Competition remains to serve predominantly one specific purpose – early identification and specialization of talented athletes. This is enabled by the School Sports Promotion Act and the regulation of the competition that limits participation only to registered "student-athletes."

Chapter 3. Theoretical Framework and Research Questions

3.1. Theoretical Framework

By aligning the key and common characteristics (discussed in Chapter 2), on the theories of SMTD and sport specialization with those of Korea's Sport Talent Development System, the theoretical framework (Korean Model of Sport Talent Development) of this research is formed.

It is observed that the Korean Model of Sport Talent Development :

- separates "elite" and "sport-for-all" population by law and separates their participation – i.e. limiting participation in National Junior Athletic Competition to solely registered "athletes" (student-athletes);
- opens the door for "early identification" of talented athletes by enabling 4th grade student-athletes (age 10) to participate in organized national-level sports games;
- promotes "early, single specialization" by entitling student-athletes as "special sport talent" and ranking them through interscholastic competition, immediately placing them in a goal(purpose)-oriented training environment;
- strengthens adherence to this "athlete pathway" by granting those

who have entered the system i) an opportunity to advance to higher education depending on their sport performance, ii) special rights in receiving education, and iii) preferential rights or even exemption from Korea's mandatory military service (for men).

With this observation, we can further extract under-lying assumption of Korean Model of Sport Talent Development where;

- the sport policy of Korea on elite sport essentially aims to raise an international-level athlete, who is identified as special sport talent at early stage, engage in one main sport with exclusion of others at the earliest possible stage so as to accumulate most hours of practice leading up to the highest level of eventual performance.
- With progression towards higher levels, it removes less talented from the system, and strengthens earlier talent-identified athletes' adherence to the sport career path and their continued success.

3.1.1. Research Subjects

3.1.1.1. Subject Sport

Now knowing that our theoretical framework, Korean Model of Sport Talent Development, posits early identification of talent and early specialization, it isn't surprising to note that Korea has seen global-scale

success in early-entry sports (gymnastics, figure skating, table tennis at the highest level, and rhythmic gymnastics and diving at sub-top level) discussed in western literature.

On the other hand, Korean Athletics, a foundation (but late specialization) sport alongside (early specialization) swimming and gymnastics in Korea, and with that granted status has also enjoyed extensive and continued government funding as well as financial sponsorship and managerial engagement of conglomerates such as KEPCO and Samsung over the past decades.

From government's point of view, apart from the characteristics of athletics that are "foundational" (for developing basic and essential bio-motor abilities and skills), it is a foundation sport for it has most number of medals in major sports events such as Asian Games and Olympic Games.

However, despite the continued external support, the sport has attained only two Olympic medals in its history; one (to some political dispute) attained in 1936 Berlin Olympic Games by marathon runner Mr. Son Keechung, and the other in 1992 Barcelona Olympic Games in the same event by Mr. Hwang Yeongjo. It is also noteworthy to acknowledge that only one of the two medals actually falls within the era where government's support for sport was activated and systematized.

Therefore, the sport's continued under-performance at international level has caused concerns for many stakeholders and sport researchers in the academic field. As previously mentioned in the introduction, and with the established theoretical framework, we will henceforth attempt to validate the efficiency and effectiveness of Korean Model of Sport Talent Development surrounding Korean Athletics.

3.1.1.2. Subject Athletics Events

Athletics is composed of four main event-groups. These are sprint/hurdles, middle/long distance, jumping, and throwing event-groups.

For the following reasons, sprint event group will be selected as the subject of this research :

- It is easier to ensure consistency of measure for sprint event athletes, majority of whom stay with one or two main events (i.e. 100m or 200m) throughout their career.
- Most field events (throwing and jumping) require costly implements and equipment, which may act as extraneous variables in conducting the research (i.e. available only in those schools or institutions that can afford them)
- Since transfer to another distance event (i.e. from 5000m to 10,000m, half-marathon to marathon) is progressive and frequent in

middle/long distance (with maybe 800m/1500m exceptions), it is difficult to ensure consistency of measure with this event-group.

3.2. Research Questions

Based on the theoretical framework established for this research, following research questions are formulated to best assess the efficiency and effectiveness of the Korean Model of Sport Talent Development on accomplishing its intended goals of producing high performance athletes.

- RQ 1. Are early talent and early specialization in athletics prerequisites for eventual top performance in the same sport?

- RQ 2. What are the characteristics of eventual top performers in athletics?

Chapter 4. Methodology

4.1. Overview

This research will incorporate statistical analysis using athletes' data acquired from i) Korea Association of Athletics Federations, ii) memory recall survey on target subjects, and iii) other available and published resource such as the IAAF Top List (ranked by performance) on the website of International Association of Athletics Federations.

4.2. Research Parameters and Definitions

4.2.1. KAAF Athletes' Database

One of the most important chunks of data will be acquired from KAAF's Athletes Performance Database which contains not only athletes' official performance results, but also their membership registration history, affiliated teams, date and year of birth, etc.

Upon prior consultation with KAAF's competition management department, it was discovered that by year 2000, KAAF computerized all of past athletes' data (manually managed up to this point), and began to operate computerized athletes (performance) results management system. Henceforth KAAF was not 100% confident about reliability of data leading

up to 2000 and was reluctant to provide such for research purposes, but agreed to officially provide athletes' profile and performance related data from year 2000 and onwards. Therefore, this research limits the scope of its statistical data from 2000 to the date of data acquisition, 18th September, 2018.

4.2.2. Drawing a line between Early and Late Specialization

The core theme of this research lies with distinction between "early" and "late" specialization; therefore, a boundary needs to be drawn between these two before carrying out the research.

As had been reviewed in Chapter 2, there does not seem to exist an agreement on which starting age of specialization constitutes either as an early specialization or late specialization. Indeed, each sport discipline is unique and different, and as Balyi (2004) points out approach to designing a training program for athletes should be individual and incorporate biological and training age of athletes since individual genetics and history are different.

However, since we are conducting our research on a large number of target athletes with a time span of 19 years (2000-2018), and do not aim to measure in depth the athletes' biological age or identify the age of Peak

Height Velocity (PHV) suggested by Balyi as a reference point, it is logical that we implement a generic distinction by drawing a separation line(chronological age) to define these two types of specialization within the scope of the research.

Some aspects from the theories of authors discussed in our review hint at where this separation may lie, and Table 1. puts together and summarizes Balyi's stages of athlete development model for late specialization(Balyi and Hamilton, 2004), and Côté's Developmental Model of Sport Participation(Côté et al., 2007).

Table 1. Distinction between Early and Late Specialization

<table>
<tr><td>Age</td><td>School Grades</td><td colspan="2">Istvan Balyi</td><td>Jean Côté</td></tr>
<tr><td>…</td><td>Korea</td><td colspan="2">LTAD</td><td>DMSP</td></tr>
<tr><td>…</td><td></td><td>Male</td><td>Female</td><td>Male & Female</td></tr>
<tr><td>6</td><td></td><td rowspan="4">Stage 1</td><td rowspan="4">Stage 1</td><td rowspan="7">Sampling</td></tr>
<tr><td>7</td><td>Elem. 1</td></tr>
<tr><td>8</td><td>Elem. 2</td></tr>
<tr><td>9</td><td>Elem. 3</td></tr>
<tr><td>10</td><td>Elem. 4</td><td>Stage 1 - 2</td><td>Stage 1 – 2</td></tr>
<tr><td>11</td><td>Elem. 5</td><td rowspan="3">Stage 2</td><td>Stage 2</td></tr>
<tr><td>12</td><td>Elem. 6</td><td>Stage 2</td></tr>
<tr><td>13</td><td>Mid. 1</td><td>Stage 2 - 3</td><td rowspan="3">Specializing</td></tr>
<tr><td>14</td><td>Mid. 2</td><td>Stage 2 – 3</td><td rowspan="2">Stage 3</td></tr>
<tr><td>15</td><td>Mid. 3</td><td>Stage 3</td></tr>
</table>

16	High. 1			Investment
17	High. 2		Stage 3 – 4	
18	High. 3	Stage 3 - 4	Stage 4	
19	Univ./Senior	Stage 4		
...	...	...	...	...

Stage 3(the Training to Compete Stage) in Balyi's late specialization model is when athletes in engage in individualized, high intensity sport-specific training all year round(Balyi and Hamilton, 2004). He defines this stage as between the ages of 14-18 and 13-17 respectively for males and females. In Korea's education system, this age range corresponds to middle school 2nd grade to high school 3rd(last) grade for males, and middle school 1st grade to high school 2nd grade for females. Furthermore, Côté et al. (2007) have suggested age 13-15 as specializing stage where deliberate practice takes up at least 50% of total involvement in sport.

Putting these generic age demarcations alongside each other, we can deduce that specializing before middle school (age 13) may constitute as "early" specialization. Therefore, for the purpose of statistical analysis, specializing before age 13 will be labelled "early specialization," and on or after age 13 as "late specialization."

4.2.3. Operational Definition: Specialization

Incorporating the general definition of sports specialization in 2.2.1, "specialized training" would be defined as "participating in intense training on regular basis continued for at least 8 months of year under the direction of a coach for the purpose of enhancing performance and outcomes." This definition will be presented in the web-based (memory recall) survey to help guide the subjects fill in the actual age they began specialization in athletics.

4.2.4. Operational Definition: Early Talent and Early Specialization

According to our age demarcation between early and late specialization, showing talent in elementary school division would be regarded as "early talent." In realistic terms, this research will label those athletes who appeared at national-level athletics meetings in elementary division as "early talent". As aforementioned, similar approach will be used for "early specialization" where athletes who began specialization in athletics in elementary school age would be regarded as "early specialized'.

4.2.5. Critical Periods (of Development)

As pointed out by Balyi(2004) Peak Height Velocity (PHV) could be a good reference point in athlete's development, but PHV had been

measured in longitudinal cohort studies (Tanner JM, Davies PS , 1985, Lee et al. 2004, Granados, A. et al 2007, Chae HW et al, 2013), and it will not be appropriate to expect that the subjects would be able to accurately report the age of their PHV on a survey. However, onset of secondary sex character is closely related to PHV and is an important visible phenomenon in an individual's life. Therefore, subjects will be asked and expected to report with high accuracy their onset age of secondary sex character. This data will be used in statistical analysis to see whether the starting age of specialization in relation to onset age of secondary sex character has any relationship with later performance of athletes.

4.3. Overview of Research Methods for each Research Question

- RQ1: Are early talent and early specialization in athletics prerequisites for eventual top performance in the same sport

Table 2. Variables for Correlation Analysis

Variables	Operational Definition
Early ability/talent variable	Athlete's highest seasonal ranking in elementary division
Later/eventual performance variable	Same athlete's highest ranking in KAAF Top List(2000-2018)

Table 2 summarizes variables that will be used for correlation analysis for RQ1, which would pertain only to those athletes that began specialization in athletics in elementary school age and who also appeared at national level meeting in the same category.

As KAAF only maintains athletes' performance established at national-level meetings, the performance data provided in respect to performance ranking per sprint event in elementary division per year from year 2000 to 2018 would contain only those "early talent" athletes conforming to our operation definition of RQ1. Response data from memory recall survey would further provide verification on who among this group actually began athletics specialization in elementary school age, assisting us to identify "early talent and early specialized" population.

Furthermore, KAAF Top List (2000-2018) for sprint events contains best performances established within this time span ranked in ordinal scale. By cross-referencing above subjects with the Top List, we will be able to identify the later performance of "early talent and early specialized" population. This would enable us to conduct a correlation analysis that will involve concerned athlete's highest seasonal ranking in elementary division (early ability variable) and same athlete's eventual highest ranking in KAAF Top List (later performance variable).

- RQ2: What are the characteristics of eventual top performers?

Operational definition of this research question involves a multitude of independent variables that have been identified through literature review and formation of the theoretical framework. These variables are summarized in Table 3.

Table 3. Variables for Multiple Regression

Variable	Operational Definition & Level of Measurement	Type
Gender	Female (0) or Male (1)	Nominal
Sampling	Whether the athlete had (continued) participation in any other sport or physical activities prior to or concurrently with specialization in athletics (1) or not (0)	Nominal
Specialization (Type)	Whether the athlete specialized in elementary school age (0; early specialization) or after (1; late specialization)	Nominal
Specialization (Critical Period relative)	Specialization before (0), on/after (1) appearance year of secondary sex characteristics	Nominal
Specialization (Gap)	Whether there was any gap in specialization (1), or not (0)	Nominal
Specialization (Duration)	Total duration(years) of athletics specialization up to the year of athlete's best performance ranked in Top List	Ratio
Motivation (Higher Education)	Motivation to advance to higher education through engagement in athletics specialization Likert Scale: Lowest (1) – Highest (5)	Ordinal
Motivation	Motivation for military service exemption through	Ordinal

(Military Exemption)	engagement in athletics specialization (men only) Likert Scale: Lowest (1) – Highest (5)	
Motivation (Life Career)	Motivation to engage in athletics as life career Likert Scale: Lowest (1) – Highest (5)	Ordinal
Perceived (Physical Advantage)	Perceived physical advantage compared to other competitors Likert Scale: Lowest (1) – Highest (5)	Ordinal
Perceived (Mental Advantage)	Perceived psychological/mental strength compared to other competitors Likert Scale: Lowest (1) – Highest (5)	Ordinal
National-level appearance (Elementary division)	Whether the athlete appeared at national level athletics meeting in elementary division (1), or not (0)	Nominal
National-level appearance (Elementary division_Final round)	Whether the athlete appeared in the final round of national level athletics meeting in elementary division(1), or not(0)	Nominal

With actual input data acquired from web-based survey on subjects, binary coded (0 or 1) variables for Sampling, Specialization(Type), Specialization(Critical Period relative), Specialization(Gap) will be created. National-level appearance (Elementary division) and National-level appearance (Elementary division_Final round) will also be binary coded, but this data will be verified through data acquired from KAAF's athletes' performance database.

Secondary factors such as Motivation (Higher Education), Motivation (Military Exemption), Motivation (Life Career) will be used to assess at athlete's perception level if the functions or tools that are put in place to encourage and enhance performance of Korean athletics are serving their right purposes. These variables along with Perceived (Physical Advantage) and Perceived (Mental Advantage) will be measured using Likert Scale from 1 to 5 on the web-based survey.

4.4. Conduct of Data Collection and Analysis

Two bodies of data were required as a starting point of data collection and analysis. One was the Top (Performance) List of Sprint Events in Elementary School Division (80m,100m,200m), and the other was KAAF Top (Performance) List in Sprint Events (100m,200m,400m). The former will be hereafter named Data Set 1, and the latter Data Set 2.

4.4.1. Procedure ONE: Initial data collection

4.4.1.1 Data Set 1: Top List of Elementary School Division by Year (2000-2018)

Sprint events in elementary school division are composed of 80m (pertaining to 4th and 5th grader only), 100m and 200m (pertaining to both

5th & 6th graders). KAAF provided elementary school division top performance lists (ordered by ranking) per each event per each athletics season(year) starting on 1st January, 2000 to 18th September, 2018. This meant 6 individual events' (80m, 100m, 200m events for boys and the same for girls) Top Lists per year times nineteen seasons(years).

This data was provided in the form of excel spreadsheet with 7025 rows of data ; each row containing athletes' data in columns of rank(pertaining to the relevant year), performance, wind readings, year of competition, month of competition, name of competition, division, name of event, affiliated city/district, registration number, name, year and date of birth, etc.

4.4.1.2 Data Set 2: KAAF Top List (2000-2018)

The second body of data collected was Top (Performance) List of Sprint Events dating from 1st January, 2000 to 18th September, 2018. This list contained any best performances regardless of division for the relevant event (presumably, and mostly performances achieved by seniors). The initial data included Top 190 athletes per sprint event totalling in 1,140 rows of data with each row containing athletes' data in columns of rank(2000-2018), performance, wind readings, year of competition, month of

competition, name of competition, division, name of event, affiliated city/district, registration number, name, year and date of birth, etc.

What was observed from this data set was that as we moved down the ranking list, performance of high school (and even a few middle school) athletes became more frequent, suggesting not only that Korea's elite pool has been very narrow (2000-2018), but also that the ordinal list needs to be cut at some point without severely affecting the sample size for eventual statistical analysis. Eventually it was decided that the list would contain up to Top 100 for each event (6 in total) in consideration there will be further reduction in the total sample size due to those athletes who perform in multiple events (duplicates) in sprint-event group.

4.4.2. Procedure TWO

In order to identify those athletes who began participation in athletics early (elementary division) and have progressed to perform at higher level thereby ranking themselves in Data Set 2, both sets of data were cross-checked.

The resulting quantity and age range of athletes that appear in both sets of data is seen in Table 4.

Table 4. “Early Talent” Athletes in KAAF Top List (2000-2018)

Category	Total	Age Range_Birth Year	
Male	39	1989	2001
Female	50	1988	2004

The (range of) years of competition in elementary division that correspond to two genders’ identified age range (Age Range_Birth Year) is shown on Table 5.

Table 5. “Early Talent” Athletes’ in Top List – Relevant Years

Pertaining Years_Age Range						
Boys' Competition Year				Girls' Competition Year		
100m	2000	2013		100m	1999	2016
200m	2000	2013		200m	1999	2016
80m	1999	2012		80m	1998	2015

Since this research uses KAAF’s performance data from year 2000 and onwards, Table 6 shows actual available data.

Table 6. “Early Talent” Athletes’ in Top List – Available Data

Pertaining Years_Available Data						
Boys' Competition Year				Girls' Competition Year		
100m	2000	2013		100m	2000	2016
200m	2000	2013		200m	2000	2016
80m	2000	2012		80m	2000	2015

Total number of athletes registered in sprint events in corresponding years are shown on Table 7.

Table 7. Elementary Division Membership in Sprint Event Group

Membership	Boys	Girls
Total	6777	6947
Years	2000-2013	2000-2016

4.4.3. Procedure THREE

In order to identify how many athletes actually appeared at national-level meetings in elementary division in the relevant (pertaining to age group) years, following procedures were taken

- Deletion of unrelated years of data from Data Set 1 – this resulted in total 5273 rows of data (both genders inclusive) remaining.
- Begin overall data accuracy check and fix in Data Set 1. Broken data was fixed by referencing athletes' birthdates, registration number, membership data, and athletes who changed their names in later years were identified as well. This resulted in 4 rows of data being deleted in boys' data. Broken or mistyped data identification and correction involved 20 rows of data in boys and 40 rows of data

in girls.

- By erasing duplicates to attain total number of athletes' who appeared at national-level athletics meetings in elementary division in pertaining years, following figures were identified ; the youngest identified on Data Set 2 (Top 100) was born in 2002 in men's case, and 2004 in girls'. Therefore, from "Pertaining Years_Available Data", birth year was limited for each gender to match and find the relevant population.

Table 8. "Early Talent" Total (Pertaining Years)

Early Talent in Sprint Events	Boys	Girls
Total (Pertaining Years_Available Data)	1496	1566
Pertaining Birth Years	1989-2001	1988-2004

4.4.4. Procedure FOUR

Same procedures (2 & 3) were conducted against Data Set 2 to identify following information.

Table 9. Total "Early Talent" Athletes in Top List (Data Set 2)

KAAF Top List (2000-2018)	Men	Women	Total
Total	208	191	399
Pertaining to Age Group	39	50	89

4.4.5. Procedure FIVE

Membership data was searched and filled in both data sets, and additionally columns were added to mark following information:

- If no registration for the last two years (2017-2018): retired
- If no registration for last year (2018): not retired
- At least two continued registration regarded as starting year of continued registration
- Other non-registration years separately noted

4.4.6. Procedure SIX: Memory Recall Survey

The subjects of memory recall survey were 399 in total, including both active and retired athletes' whose performance results appear in Data Set 2.

4.4.6.1. Construction and Test runs of Memory Recall Survey Questionnaire

After three offline meetings (4th May, 2018, 23rd November, 2018, 13th January, 2019) with the advisor to receive consultation on the variables to be incorporated on the survey, survey construct was finalized.

Test runs of the memory recall survey involved the head coach of national junior sprint team, a sport high school head coach, former general director of national university athletics association, two top sprint athletes,

and one former/retired sprint athlete who is an official lecturer for KAAF's coaches' education program. Their feedback on the questionnaire was reflected in some degree.

4.4.6.2. Conducting Survey

Korea Association of Athletics Federations (KAAF), being a national governing body of Korean athletics, assumes some authority over athlete and team's membership registration and entry in KAAF sanctioned meetings/competitions. Therefore, in order to promote and enhance response rate to the web-based survey, the survey questionnaire was submitted to KAAF for their approval to send out to target population via KAAF's official Short Message Service (SMS) tool, using athletes' phone numbers registered on KAAF's athlete database.

Google survey link was sent out via KAAF's official SMS (Short Message Service / 02-414-3032) on 28th of February, 2019 with a deadline of 3rd of March. By the deadline 89 subjects had submitted the surveys. On 4th March, second reminder SMS was sent out to non-respondents with encouragement to fill in the questionnaire by 18:00 of 5th March, by which date the respondents accumulated to 198. From 6th to 15th March, two KAAF employees assisted with telephone calls to the remaining non-

respondents encouraging response and also re-sending the survey link. During this procedure, (among 201 remaining non-respondents), 142 subjects' phone numbers were found to have been changed, unable to connect, become non-existent, or incorrectly registered on KAAF's athlete database. From 18th to 22nd March, 11 sprint coaches and 3 former athletes and 3 active athletes assisted with either finding the latest phone numbers or encouraging their acquaintances or friends among the subjects to respond. By 24th March, a total of 301 responses had accumulated. Among these, 2 were initial test runs, and two were submitted by non-subjects of the research. 5 people had submitted twice, so the latest submission was kept and former deleted. One was submitted by a different former-athlete of same name. Eventually with last submission of survey on 29th March, there were 294 subjects' response received and valid for analysis.

Table 10. Survey Response Rate

Subjects	Data Set 2 (Top List)	Response	Response Rate
Men	208	164	78.84%
Women	191	130	68.06%
Total	399	294	73.68%

4.4.7. Procedure EIGHT: Merging, Adjusting and Finalizing Data Set 2 Alpha

4.4.7.1. Merging

Name and birthday information were cross-checked between Data Set 2(which now included cross-referenced data from Data Set 1) and survey data. Once confirmed to be the same person, the relevant fields of data in the survey were merged with the respective rows in Data Set 2. The end product of this process was Data Set 2 Alpha.

4.4.7.2. Adjusting input variables in Data Set 2 Alpha

- *Sampling (Sport and duration)*

Since the subjects were asked to input their sampling (prior sport or concurrent sport) period and relevant sport to the best of their memory, the input data had variations in form (i.e. 2nd to 3rd grade in elementary, age 15-16, 8 months in 5th grade in elementary, etc). Most cases were written in years instead of more specific duration in months.

When the data indicated two years participation in Taekwondo, it was adjusted as 1.5 years. three years to 2.5 years, FOUR years to 3.5 years, and so forth to minimize the risk that their response is overestimated. When the data was written in months (i.e. 9 months), this was converted to years (9/12) to the second decimal (0.75) of year.

If the subject had participated in a number of valid sampling sports, then the sampling years of each sport were summed to produce “sampling

duration."

Observing the data of those who had participated in other continued(more than 8 months) physical activity or sport, athletes seemed to have clear memory of when as in what grade or age they began or ended continued participation in other physical activity, but had hard time recalling the exact month or time of the year.

Even though this data refining took place, however, eventually only the binary coded variable of sampling explained below was used for the multiple regressions.

- *Sampling before peaking*

As our research is looking for past history of participation in other sports or physical activities other than athletics before reaching their full potential in athletics, only those sports or physical activities participated prior to peaking age (in athletics) was taken into account. Any participation that began after peaking age (in athletics) was disregarded. With this information, a binary coded variable of "Sampling" was created with "0" for "sampling period not reported", and "1" for "sampling period existed before reaching peak performance in athletics."

- *Prior or concurrent sampling*

If input data said that participation in sport A lasted until elementary school year 3rd grade, and that athletics specialization began in the same year, then it was regarded as prior participation. This was due to the logic that participation in sport A ended in that year because specialization in athletics began.

- *Main event group in athletics*

Although survey questionnaire clearly asked what event group their main event belonged, some subjects chose sprint event group and indicated their current main event in the "other athletics event" category. This data was reviewed and adjusted.

- *Starting age of athletics specialization*

There were a number of cases, where the subject had input the starting age of athletics specialization in a specific year, and then also answered the gap in specialization was either the same year or the year(s) after. For example, if starting age of athletics specialization input was 6th grade in elementary school, and the gap in specialization indicated 6th grade elementary to 2nd grade in middle school, the starting age of specialization was adjusted to 3rd grade in middle school to conform to the concept of

specialization discussed in previous chapters(i.e. continued without a gap ; continued accumulation of deliberate practice). On the other hand, there was also a few who gave this a considerable thought, indicating that there was a gap and then actual continued specialization began after.

After adjusting and aligning all data fields in terms of “age”, a binary coded variable of “Specialization (Type)” was created with “0” for “specialization on or before last grade in elementary school age or age 12”, and “1” for “specialization on or after age 13.” Here binary code “0” conforms to the operation definition of “early specialization,” and “1” to that of “late specialization” (4.2.2)

- *Dependent Variables*

When we use highest ranking in each sprint event or any other athletics event where the subject athlete established high performance ranked in KAAF Top List(2000-2018), there are multiple duplicates in the DVs due to the fact that multiple sets of 1-100 range rankings are used (Top 100 for Men’s 100m, women’s 100m, men’s 200m and so forth making six sets of Top 100). It was observed that this duplication in ranking squeezes and skews the distribution to one end and did not provide enough variance for valid regression analysis (Figure 3).

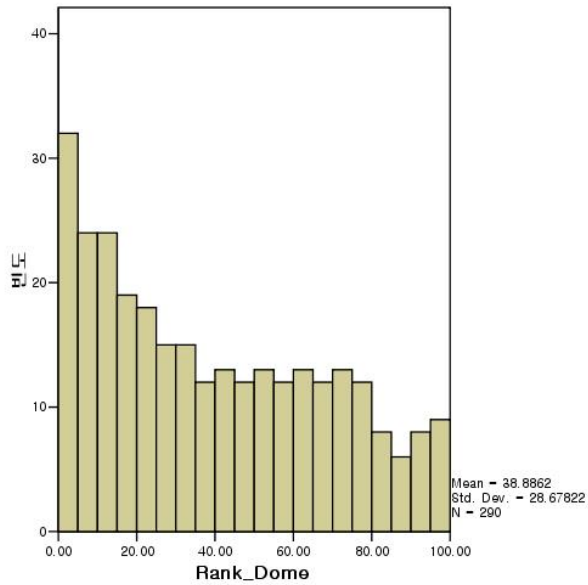

Figure 3. DV: Domestic (KOR National) Ranking

Therefore, what produced better distribution histogram with enough variance and distinction among each performance was Relative Area Ranking and Relative World Ranking (Figure 4 & 5). These were produced by comparing every performance result (i.e. 10.07 in Men's 100m) in Data Set 2 Alpha with the latest 2018 IAAF Area (Asia) and World Top List, and identifying its relative ranking position in the respective list.

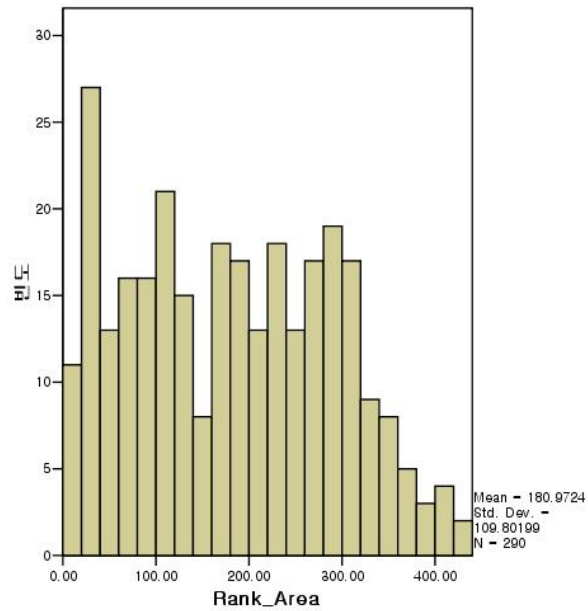

Figure 4. DV: Relative Area Ranking

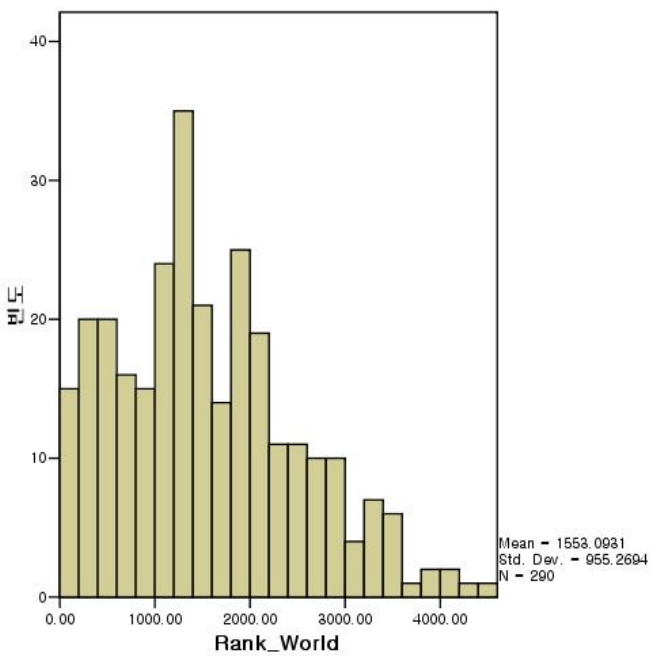

Figure 5. DV: Relative World Ranking

In identifying subjects' relative position/ranking in Area(Asia) and World Lists, 4 subjects' relative positions could not be identified as the IAAF Top Ranking List had limit for each event on how far the (performance) rankings are posted. This resulted in 4 Women's 100m sprint athletes' data being excluded from the DV list, with final size of sample ending up in 290 composed of 162 men, and 128 women subjects (Table 11).

Table 11. Finalized Data Set 2 Alpha

Subjects	Data Set 2 Alpha for Multiple Regression
Men	162
Women	128
Total	290

Eventually, after observing the histograms of three different DV sets (Domestic, Area, and World), for the most valid statistical analysis, Relative World Ranking was chosen as DV for multiple regressions as it provided most variance and was closest to normal distribution (though right-tail skewed) among other DV sets.

Chapter 5. Results and Findings

5.1. Descriptive Statistics in relevance to the RQs.

5.1.1. Elementary Division Statistics

Table 12. Elementary Division Statistics

Boys	*Relevant Years*	*Quantity*
NA_E Finalists progressed to Top 100	Birth Year 1989-2001	27
NA_E progressed to Top 100	Year 2000-2018	39
Total Athletes(age_group) in Top 100	Birth Year 1989-2001	129
Total Athletes in Top 100	Birth Year 1970-2002	208
Total National-level appearance (Elementary division) in Sprint Events	Birth Year 1989-2001	1496
Total Membership in Sprint Events (Elementary)	Year 2000-2013	6777
Girls	*Relevant Years*	*Quantity*
NA_E Finalists progressed to Top 100	Birth Year 1988-2004	38
NA_E progressed to Top 100	Year 2000-2018	50
Total Athletes(age_group) in Top 100	Birth Year 1988-2004	116
Total Athletes in Top 100	Birth Year 1972-2004	191
Total National-level appearance in Sprint Events	Birth Year 1988-2004	1566

Total Membership in Sprint Events (Elementary)	Year 2000-2016	6947

As outlined in Chapter 4, age range of those athletes who appeared at national-level in elementary division and progressed to rank in the Top List were identified for both genders (Men: 1989-2001; Women: 1988 – 2004). The total number of athletes with same age range respectively for men and women in the Top List were 129 for men (among 208 total) and 116 for women (among 191 total). This means that among the same age group in the Top List, those who appeared at national-level meeting in elementary division (early talent group) take up 30% in men and 43% in women. On the other hand, 70% of men, and 57% of women were those who did not appear at national-level elementary division (not early talent), but had nevertheless progressed to rank in the KAAF Top List (2000-2018).

5.1.2. Distribution of Athletics Main Events (Survey Respondents)

The subjects were asked to report their latest(eventual) main events in athletics, and Table 13 summarizes this distribution.

Table 13. Distribution of Main Events

Total(n=294)		
Combined Events	3	1.02%
Hurdles(100mH,110mH,400mH)	26	8.84%

Jumping Events (Long Jump, Triple Jump)	6	2.04%
MLD (800m)	14	4.76%
Sprint(100m,200m,400m)	245	83.33%
Men(n=164)		
Combined Events	1	0.61%
Hurdles(110mH,400mH)	10	6.10%
Jumping Events (Long Jump, Triple Jump)	4	2.44%
MLD (800m)	7	4.27%
Sprint(100m,200m,400m)	142	86.59%
Women(n=130)		
Combined Events	2	1.54%
Hurdles(100mH,400mH)	16	12.31%
Jumping Events (Long Jump)	2	1.54%
MLD (800m)	7	5.38%
Sprint(100m,200m,400m)	103	79.23%

Although this research initially intended to target those athletes ranked in sprint event-group (100m,200m,400m), it was expected that athletes who mainly specialize in athletics events other than sprint events would also be found on the list. Speed is one of the key components in any athletics events and that those athletes especially with good locomotive/horizontal speed do not only specialize in sprint events, but also in short and long hurdles, long jump, etc. Indeed, the proportion of main events of the subjects confirms this notion that only those track events

(100mH, 110mH, 400mH, 800m) whose distance is not too far from sprint events(100m,200m,400m) are found. There were also horizontal jumping events (long jump, triple jump), and a few combined events. No throwing events, or middle/long distance events longer than 800m was reported. Therefore, the relevant highest rankings of those whose eventual main events were other than sprint events were also identified and reflected in the DV column respectively.

5.2. Answering RQ1: Are early talent and early specialization in athletics prerequisites for eventual top performance in the same sport?

Among the 39 male athletes and 50 female athletes who appeared at national-level athletics meetings in elementary division (operational definition of early talent), 32 men and 37 women had responded to the survey giving us input data for starting “age” of specialization. Among them, those who actually specialized in elementary school were 21 for men, and 32 for women. Table 14 shows Pearson product-moment correlation analysis conducted between their highest ranking in elementary division (in the relevant year) and eventual ranking listed in Top List (2000-2018) for

the two genders.

Table 14. Correlation between Highest Ranking in Elementary Division and Highest Ranking in Top List

Gender	Pearson's correlation (r)
Men (n=21)	-.436(*)
Women (n=32)	.198

* Correlation significant at the 0.05 level (2-tailed)

In women's case there was no significant relationship found between the two variables. In men's case, however, results indicated inverse relationship at significant level of $p<0.05$ between the ranking variable of "early talent and early specialization" and "eventual performance."

5.3. Answering RQ 2: What are the characteristics of eventual top performers?

In order to investigate the characteristics of eventual top performers, multiple regressions were carried out to see which factors(variables) identified through literature review and formation of the theoretical framework were in significant relationship with expected outcome of the Korean Model of Sport Talent Development. Linear multiple regressions

were conducted with variables in Table 3, with Relative World Ranking as DV.

5.3.1. Multiple Regression ONE

Multiple regression was first executed with total sample population of 290 comprised of 164 men and 126 women.

Table 15. Summary of Multiple Regression ONE (N = 290)

Variable	*B*	*SE B*	*β*
(Constant)	3000.359	280.508	
Gender	-628.001	97.651	-.326**
Sampling	-7.821	109.652	-.004
Specialization (Type)	-337.231	120.117	-.173**
Specialization (Critical Period relative)	95.066	118.116	.049
Specialization (Gap)	-149.735	102.773	-.072
Specialization (Duration)	-95.245	11.332	-.448**
Motivation (Higher Education)	83.454	50.701	.090
Motivation (Life Career)	-104.404	48.167	-.117*
Perceived (Physical Advantage)	61.360	58.795	.058
Perceived (Mental Advantage)	-85.278	55.312	-.088
R^2	.348		
Adjusted R^2	.325		
F	14.897**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

The coefficient of multiple determination was .348 meaning that the independent variables explained 34.8% of dependent variable 'Relative World Ranking.' Having a F-value of 14.897 at p-value < .01(α), the multiple regression was significant in explaining the DV.

'Gender', 'Specialization (Type)', 'Specialization (Duration)' had significant relationship with DV at p-value < .01(α), and 'Motivation (Life Career)' at p-value < .05(α). The four IVs were in negative (-) relationship with the DV, meaning increase in these variables would enhance the eventual performance (or relative position in the World Ranking).

5.3.2. Multiple Regression TWO

In order to see whether similar result as Multiple Regression ONE would come out for the relevant age group, and to include National-level appearance(Elementary division) and National-level appearance (Elementary division_Final round) variables in the regression, second multiple regression was conducted against age-group matched population within the sample population of Multiple Regression ONE.

Again, this population not only included athletes who appeared at national-level in elementary division, but also other athletes of same age

range who nevertheless progressed to rank in the Top List. In other words, these were “early talent and early specialized” group and their same age group athletes in the Top List. This sample was 192 athletes comprised of 110 men and 82 women.

Table 16. Summary of Multiple Regression TWO (N = 192)

Variable	*B*	*SE B*	*β*
(Constant)	3546.566	362.393	
Gender	-707.122	116.676	-.366**
Sampling	-148.058	124.479	-.070
Specialization (Type)	-464.645	163.461	-.236**
Specialization (Critical Period relative)	171.767	152.579	.090
Specialization (Gap)	-125.733	119.487	-.062
Specialization (Duration)	-133.927	16.912	-.503**
Motivation (Higher Education)	26.617	61.351	.028
Motivation (Life Career)	-144.338	58.285	-.162*
Perceived (Physical Advantage)	106.748	72.126	.099
Perceived (Mental Advantage)	-110.000	68.636	-.112
National-level appearance (Elementary division)	-95.329	199.925	-.047
National-level appearance (Elementary division_Final round)	112.387	206.149	.050
R2	.410		
Adjusted R2	.370		
F	10.352**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

The coefficient of multiple determination was higher in this regression with .410(41.0%), and F-value was 10.352 at p-value < .01(α).

Same IVs 'Gender', 'Specialization (Type)', 'Specialization (Duration)' had significant relationship with DV at p-value < .01(α), and 'Motivation (Life Career)' at p-value < .05(α). Similarly, to Multiple Regression ONE, the four IVs were in negative (-) relationship with the DV, meaning increase in these variables would enhance the eventual performance (or relative position in the World Ranking).

5.3.3. Multiple Regression THREE(M) and THREE(F)

Having observed that "Gender" variable is significant in both Multiple Regression ONE and TWO, additional multiple regressions were conducted to further investigate the characteristics for men and women separately.

5.3.3.1. Multiple Regression THREE(M)

Table 17. Summary of Multiple Regression THREE(M) (N = 110 Men)

Variable	*B*	*SE B*	*β*
(Constant)	1988.882	414.347	
Sampling	-304.926	133.653	-.206*

Specialization (Type)	-11.692	191.233	-.008
Specialization (Critical Period relative)	-88.181	164.681	-.063
Specialization (Gap)	89.395	128.416	.062
Specialization (Duration)	-83.832	19.332	-.404**
Motivation (Higher Education)	153.953	63.349	.235*
Motivation (Military Exemption)	32.295	49.710	.061
Motivation (Life Career)	-151.764	60.552	-.252*
Perceived (Physical Advantage)	39.536	80.211	.049
Perceived (Mental Advantage)	-86.079	75.611	-.121
National-level appearance (Elementary division)	-423.740	232.272	-.275
National-level appearance (Elementary division_Final round)	517.745	245.048	.296*
R2	.300		
Adjusted R2	.214		
F	3.468**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

The coefficient of multiple determination was .348 meaning that the independent variables explained 34.8% of dependent variable ‘Relative World Ranking.’ Having a F-value of 14.897 at p-value < .01(α), the multiple regression was significant in explaining the DV.

The coefficient of multiple determination was .300(30%) meaning that the independent variables explained 30.0% of dependent variable ‘Relative World Ranking.’ Having a F-value of 3.468 at p-value < .01(α), the multiple regression was significant in explaining the DV.

‘Specialization (Duration)’ had significant relationship with DV at p-value < .01(α), and ‘Sampling’, ‘Motivation (Higher Education)’, ‘Motivation (Life Career)’, ‘National-level appearance (Elementary division_Final round)’ had significance at p-value < .05(α). Three IVs, ‘Sampling’, ‘Specialization (Duration)’, ‘Motivation (Life Career)’ were in negative (-) relationship with the DV, meaning increase in these variables would enhance the eventual performance (or relative position in the World Ranking). On the other hand, Motivation (Higher Education), and ‘National-level appearance (Elementary division_Final round)’ had positive (+) relationship, meaning increase in these variables would decrease the eventual performance.

5.3.3.2. Multiple Regression THREE(F)

Table 18. Summary of Multiple Regression THREE(F) (N = 82 Women)

Variable	*B*	*SE B*	*β*
(Constant)	4253.828	618.389	
Sampling	13.808	227.115	.005
Specialization (Type)	-813.624	270.518	-.371**
Specialization (Critical Period relative)	527.896	272.140	.230
Specialization (Gap)	-221.641	220.396	-.088
Specialization (Duration)	-179.834	28.090	-.633**
Motivation (Higher Education)	-208.707	117.118	-.184
Motivation (Life Career)	-170.201	116.393	-.146

Perceived (Physical Advantage)	286.503	124.171	.238*
Perceived (Mental Advantage)	-141.213	117.949	-.124
National-level appearance (Elementary division)	185.709	329.740	.084
National-level appearance (Elementary division_Final round)	-180.548	325.506	-.075
R2	.504		
Adjusted R2	.426		
F	6.471**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

The coefficient of multiple determination was .504(50.4%) meaning that the independent variables explained 50.4% of dependent variable 'Relative World Ranking.' Having a F-value of 6.471 at p-value < .01(α), the multiple regression was significant in explaining the DV.

'Specialization (Type)' and 'Specialization (Duration)' had significant relationship with DV at p-value < .01(α), and 'Perceived (Physical Advantage)' had significance at p-value < .05(α). Two IVs, 'Specialization (Type)', 'Specialization (Duration)' were in negative (-) relationship with the DV, meaning increase in these variables would enhance the eventual performance (or relative position in the World Ranking). On the other hand, 'Perceived (Physical Advantage)' was in positive (+) relationship, meaning increase in this variable would decrease

the eventual performance.

5.4. Further Investigations and Findings

Following the results of multiple regressions, further investigations (especially the age-group matched population) were conducted for starting age of specialization, onset age of secondary sex character, duration to peak performance, and sampling sports. (Table 19)

Table 19. Description of starting age of specialization, secondary sex character, and duration(years) to peak performance.

Age group matched athletes	*Men (n=110)*	*Women(n=82)*
Start of Specialization (age)	13.7±2.30	12.2±2.49
Onset of Secondary Sex Character (age)	13.9±1.44	13.8±1.67
Duration to Peak Performance (years)	5.9±3.38	6.5±3.89
Retired athletes	*Men (n=61)*	*Women(n=46)*
Duration to Peak Performance (years)	8.2±4.54	9.0±4.66

* All figures M±SD

The mean starting age of specialization differed between two genders with men's mean age at 13.7 with SD of 2.30 and women's mean age at 12.2 with SD of 2.49.

Although no significant relationship was found in multiple

regressions for ‘Specialization (Critical Period relative)’ variable, there were some notable statistics found on the reported age of appearance of secondary sex characteristics within the sample population. Surprisingly, against the general perception that women’s onset of secondary sex characteristics is 1-2 years earlier than men, the mean starting age for both genders were similar.

For the age-matched group, the mean duration to peak performance (ranked in the Top List) for men was 5.9 years with SD of 3.38, and women 6.5 years with SD of 3.89.

However, because the age-matched group contains mostly active athletes whose better later performance is to be seen, more appropriate measure for this value would come from retired athletes in the total sample of 290. There were 61 retired male athletes and 46 retired female athletes in this sample population, and the mean duration to peak performance was 8.2 years for men and 9.0 years for women with SD of 4.54 and 4.66 respectively.

Whereas sampling (availability of prior sport or physical activity) was found to be in significant relationship with eventual

performance(ranking) in men, Table 20 shows descriptive statistics of reported sampling sports and physical activities.

Table 20. Sampling Sports (N = 37 Men)

Events	Quantity	Percentage
Badminton	1	2.44%
Boxing	1	2.44%
Fencing	1	2.44%
Hapkido	2	4.88%
MMA	1	2.44%
Soccer	2	4.88%
Swimming	4	9.76%
Table Tennis	1	2.44%
Taekwondo	27	65.85%
Volleyball	1	2.44%
Sum	41	

There were 37 subjects who reported they had participated in other sports continued for at least for more than 8 months before reaching their latest peak performance in athletics. Including THREE subjects who had participated in more than 1 event, the total number of sports participated was 41. Among this population, participation in Taekwondo was predominant (65.85%). Martial arts including Taekwondo was 30 out of 41 comprising 73.17% of total number of sports participated (30 out of 37

subjects or 81% had participated in martial arts). Also, it was reported that only 1 out of 37 subjects had participation in another sport in conjunction with specialization in athletics. The rest 36 subjects reported that once they started specialization in athletics, they had no other sports participated until they reached their best performance in athletics ranked in the Top List.

5.5. Summary of Results and Interpretations

5.5.1. RQ1. Early talent and early specialization

In our attempt to answer RQ 1, we've conducted correlation analysis between early talent and early specialized athlete's highest ranking in elementary division and his/her later or eventual highest ranking in KAAF Top List. The results of this correlation, where there was no significant relationship in women, but inverse correlation found in men, suggest that early talent and early specialization combined are not prerequisites for eventual top performance, and may even adversely affect later performance in men's case.

Even though the weakness of this analysis may be the small sample size (53 in total), the findings are inconsistent with the presumption inherent in the Korean Model of Sport Talent Development, where early talent and

early specialization are key and necessary components of end-product.

As compared to the correlation analysis, the "early talent/ability" variables put in the multiple regression were binary-coded 'National-level appearance (Elementary division)' and 'National-level appearance (Elementary division_Final round)' variables.[2]

Whereas 'National-level appearance (Elementary division)' had no significance in the multiple regressions for age group matched population, 'National-level appearance (Elementary division_Final round)' was found to be in negative relationship with the eventual performance in men's case. It is also interesting to note that though having no significance, the beta values for National-level appearance (Elementary division) were all in negative values, in opposite direction to National-level appearance (Elementary division_Final round) whose beta values were all positive.

This may imply that whereas being moderately good enough to appear at national-level in elementary division may work positively for the athlete's long-term career, being too good to be in the final round in

[2] As we have operationally defined 'National-level appearance (Elementary division)' as "Early Talent", 'National-level appearance (Elementary division_Final round)' could be further defined as "Early High Talent"

elementary division may work against athlete's later performance.

5.5.2. RQ 2. Characteristics of eventual top performers

- *Specialization (Duration)*

The variable that penetrated all four multiple regressions conducted in relation to RQ2 was "duration to peak performance." This variable was found to have positive relationship with athlete's eventual performance (DV - Relative World Ranking).

Further investigation into the mean value of this variable for retired athletes found that for men it took 8.2 years on average to reach their full potential, and 9.0 years respectively for women ; these figures are not too far from the widely discussed 10-year rule of reaching expertise (Simon & Chase, 1973), and seem to conform with the general view that practice has the greatest influence on skill acquisition (Newell & Rosenbloom, 1981, Ericsson et al., 1993, Vaeyens et al., 2008).

- *Specialization (Type)*

"Specialization (Type)" was significant and in positive relationship with DV in women's case, implying that specializing "late" in middle school rather than "early" in elementary school age may positively affect

athlete's eventual performance. Though this variable showed no significance in men's case, further investigation into the mean starting age of specialization for men helped to clarify this phenomenon ; that whereas women's mean starting age of specialization rested on the boundary of elementary and middle school at 12.2 years (SD 2.49), men's mean starting age was already way into the middle school age at 13.7 years (SD of 2.31).

This could be further interpreted as that women's age group population was a mixture of "early" and "late" specialization athletes where "late" specialization athletes had better eventual outcomes, but men's age group population was already composed majorly of "late" specialization athletes.

- *Sampling*

In connection to the starting age difference in the two genders, it is interesting to note that "sampling" variable (participation in prior sport) had positive relationship with later performance in men, whose mean starting age was about 1.5 years later than women.

This may be suggesting that whereas on average successful female athletes start their athletics career earlier than male athletes, successful male athletes participate in another sport before committing, or switching their

main sport, to athletics.

- *Specialization (Critical Period relative)*

'Specialization (Critical Period relative)' variable was surveyed to see what relationship if any, the critical periods of development are in with the starting age of specialization in terms of producing the end-product (high performance). Having observed there was no significant relationship found in the multiple regressions, further investigation into descriptive statistics of the starting(development) age of secondary sex characteristics adds some interpretation to this phenomenon (Table 19).

Whereas men's mean starting age of specialization was very close to mean appearance age of secondary sex characteristics (13.72 and 13.85 years old), women's had a difference of 1.59 years (12.21 and 13.80 years old).

If we were to consider the argument of Ericsson et al. (1993) that the start of specialization must coincide with an important time-window of development(biological and cognitive) before puberty, we can add that whereas successful female athletes began accumulation of deliberate practice (specialization) in athletics before appearance of secondary sex characteristics, male athletes did the same in another sport in the same

period before converting to athletics specialization.

- *Other Factors*

Two components of the Korean Model of Sport Talent Development put in place to encourage and promote student-athlete's successful (elite) sport career, namely preferential rights in advancement to higher education and (in men's case) military service exemption for exceptional performance, were not found to be fully serving their purpose as far as the results of the multiple regressions showed.

In men's case, motivation to advance to higher education through engagement in athletics was in negative relationship with their eventual performance, whereas being highly motivated to engage in the sport as life career produced better later performance. With this result, it may not be an exaggeration to state that the tool put in place by the government to enhance athlete's performance was rather being used as a means to exploit the benefits (advancement to higher education) rather than developing the athlete in a long term, whereas those athletes with intrinsic motivation to become elite athletes were developing to become higher level athletes regardless of the preferential rights granted.

Chapter 6. Discussion and Limitations

6.1. Discussion and Suggestions

6.1.1. Korean Model of Sport Talent Development

The sport talent development model of Korea, as far as elite sport is concerned, presumes early talent identification and early specialization. The model aligns itself with a presumed Standard Model of Talent Development and the theory of deliberate practice, and posits that early specialization of early talent athletes are prerequisites of producing high level (internationally competitive) athletes that the model aims to nurture.

The model of Korea itself has been further specialized in this vein by separating and isolating “elite sport population” from the rest of the society through relevant law on sport, creation of sport specialization schools, and enforcement of student-athlete policy with entailing preferential rights. These installed tools help open the door for “early identification of talent” and “early single sport specialization”, and strengthens the elite athlete development pathway by granting them opportunities and environments to invest heavily on sport training (deliberate practice or specialization), while relatively neglecting other educational endeavours their peers undergo in the same age.

In such environment, elite sport is a secluded, government produced part of the society, where children seem talented in sport are encouraged and expected to choose their main sport early and specialize early to later become international-level athletes, with external expectations that their end product, high performance, would contribute to national morale and glory, and to integration of society through global sporting achievements.

Surprisingly, as far as the sport of athletics (mostly sprint events) is concerned, the Korean Model of Sport Talent Development does not seem to function and serve its intended goals with efficiency. This research has found that;

- early talent and early specialization combined were not prerequisites for eventual top performance,
- athletes who specialized relatively late produced better eventual/later athletics performance than early starters,
- the preferential rights implanted with the elite sport system were being exploited as a means to attain the benefits rather than functioning as stepping stones to producing higher level athletes.

These results negate the presumptions inherent in the Korean Model of Sport Talent Development and calls for a more sport-specific approach for late specialization sports.

6.1.2. Diversification or Sampling Period

The results, especially in men's case, are partially in support of the theory of early diversification or sampling. As seen in Multiple Regression THREE(M), binary coded 'Sampling' variable was significant, and further investigation found that 81% (30 out of 37) of those top men with sampling experience had participated in Martial Arts (with Taekwondo taking up highest percentage) before beginning serious engagement in athletics.

Moreover, the report that even among those that had prior participation in other sports, 97%(36 out of 37) of athletes did not have any other sport participated in concurrence with athletics specialization, and that only 8%(3 out of 37) of athletes had more than one sport participated prior to engagement in athletics career again confirms the nature of single sport specialization that the elite sport system of Korea promotes.

Therefore, whereas the concept of early diversification or sampling in the western literature hypothesizes multi sports participation in early stages of athlete's career, the concept of sampling in this research is resultantly and strictly limited to prior participation in "another" sport, rather than a number(variety) of sports, before specializing in athletics.

Whereas a multitude of western sports such as swimming, basketball, baseball, etc would fall under the umbrella term of early

diversification or sampling (or multi-sports), it is interesting to note that martial arts (mostly Taekwondo) seems to take up this function in the sport societal context of Korea. Furthermore, whereas Côté's Developmental Model of Sport Participation (Côté, 2008) ideally suggests involvement in 3-4 different sports in sampling stage, this multi-sport base is entirely replaced by one sport (mainly martial arts).

On the other hand, it is hard to argue that the male subjects intentionally partook i.e. Taekwondo training knowing that the experience will prepare them for athletics. It therefore is more logical to assume that in the general context of Korean sport we would also find in other sports those population who had undergone some form of martial arts training before beginning their career in main sport.

Although not mentioned in the findings chapter since the 'Sampling' variable had no significance in women's multiple regression, the top 2 female athletes (in 82 women sample) in Relative World Ranking also had prior participation in Taekwondo for 4.5 years and 2.5 years respectively. As compared to men, among 18 female athletes who reported they had prior sport participation (in the sample for Multiple Regression THREE. (F)), 13 had undergone martial arts training prior to athletics specialization. Again, 85% (11 of the 13) of these subjects reported they had participated in

Taekwondo.

The benefits of sampling discussed in the literature, such as preparing young athletes with important abilities (performance aspect) and promoting intrinsic motivation (psychosocial aspect) that will be beneficial in reaching eventual expert performance in the main (Côté et al 2007, 2009, and Williams & Ford 2008, Baker, et al. 2003, and Schmidt & Wrisberg 2000), do seem to concur with the results of multiple regression conducted against men where 'Sampling' and 'Motivation(Life Career)' variables had positive relationship with athlete's later performance. Investigating in this vein whether martial arts, especially Taekwondo, promotes these positive functions both in terms of performance and psycho-social aspects, and if so to what extent could be another interesting area of research.

6.1.3. Appearance of secondary sex characteristics

Finding that reported onset age of secondary sex characteristics was similar for the two genders (13.85 for men and 13.80 for women) is somewhat against the general notion that women's is earlier than men's ; the growth spurt is related to the appearance of secondary sex characteristics in puberty(Preedy, V. R., 2012), and longitudinal cohort studies on PHV(Peak Height Velocity) have shown that there is in general at least 2 years of

difference between the age of PHV for boys and girls (Tanner JM, Davies PS , 1985, Lee et al. 2004, Granados, A. et al 2007, Chae HW et al, 2013).

Having noted that the mean starting age of specialization for females was 12.2 years (closer to the defined age range of early specialization than males by 1.5 years), it may imply that this delayed onset of secondary sex characteristics for women is related to early specialization. According to IOC consensus statement on Relative Energy Deficiency in Sport (RED-S), RED-S refers to “impaired physiological function including, but not limited to, metabolic rate, menstrual function, bone health, immunity, protein synthesis, cardiovascular health caused by relative energy deficiency.” (Mountjoy M. et al, 2014).

Therefore, checking whether the nature of (especially early) specialized training in athletics in Korea conform to the mechanism behind RED-S could be necessary, if the system(Korean Model of Sport Talent Development) involved were to continue to take similar form, and most importantly for the health issue of young Korean athletes.

6.2. Limitations

6.2.1. Definition of “Sampling”

The concept of “sampling” used in this research, also referred to as

diversification in relevant literature, conceptualizes multi-sport participation experience before specializing in one or more sport, and was used in this research with an attempt to identify those athletes who had undertaken various sports before specializing in one main event(athletics), and to investigate how that experience might have been related to the eventual performance.

However, this sampling experience was discovered to be strictly limited to prior participation in mostly one sport/physical activity rather than a number of sports, so resultantly the definition of sampling in the sense of western literature(i.e. Cote) does not appropriately apply to the results of this research. The results are rather similar to the study on German athletes(Emrich and Güllich, 2006), where prior “one” sport specialization was more prevalent in international level athletes.

At the same time, this may also be a partial verification of the systemic limitation of sport culture and system in Korea, which does not provide room for multi-sport participation.

6.2.2. Critical Secondary Factors

Initially other critical secondary factors (Baker and Horton, 2004, Veerle De Bosscher et al. 2006) discussed in western literature in relation to

athlete's sports career such as i) coach's support, ii) parental support, iii) influence of peers, iv) dedication/commitment to athletics career were further segmented and added in the variables for multiple regressions and reflected in the web-based survey as well.

However, even though it is observed in literature that influence of these variables (critical secondary factors) ought to be investigated at two separate times i) at the engagement of sport, ii) throughout the sport career, test-runs of the survey revealed that the same questions repeatedly asked for two different periods of career created confusion and that respondents would regard it as duplicate error of the survey and either give same response or neglect the other, despite explanations and guidance provided on the survey page. It seems reasonable that accurate response to these secondary factors could only be achieved through in-depth interviews with the subjects, which this research did not intend to do with the given size of subjects (N 399).

As a result, these questions were asked in general sense (throughout the whole duration of athlete's career), but were eventually taken out from the multiple regressions presented in the findings. Multiple regressions conducted including these variables however showed similar results, and are provided in the appendix for readers' reference.

6.2.3. Nature of Research

As compared to the line of studies that involved investigating the specific nature and duration of specialization, this research rather put more emphasis on the environmental constraints that force early specialization of athletes. Therefore, the study did not entail inquiry into the specific characteristics of training (intensity and volume of training, etc) that the subjects had undergone, but more into the type/timing of specialization, defining of which incorporated relevant theories in literature (Balyi and Hamilton, 2004, Côté et al., 2007).

6.2.4. Scope of Research

Due to the scope of available data (2000-2018), not all sample population were former athletes' who had finished their sporting(athletics) careers. It therefore produces limitation that the results are confined to a mixture of retired athletes, and active athletes whose end-products (better performance) are yet to be seen.

Re-emphasis must also be given that the results of this research are confined to the unique nature of sport culture and system in Korea. Although some of the findings, such as specializing "late" and having "sampling" period are in positive relationship with athlete's later performance in their main event, are in partial agreement with relevant literature on "specialization", it is to be noted that the findings are specific

to the sport(athletics), culture(popular martial arts training in youth), system(student-athlete policy with entailing preferential rights to encourage early talent identification and early specialization) within the context of Korean society.

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Appendix

Table 1. Summary of Multiple Regression ONE (N = 290)

Variable	*B*	*SE B*	*β*
(Constant)	3097.629	352.039	
Gender	-653.545	98.528	-.340**
Sampling	-1.715	109.943	-.001
Specialization(Type)	-321.894	120.132	-.165**
Specialization(Critical Period relative)	97.504	117.688	.051
Specialization(Gap)	-108.698	103.133	-.052
Specialization(Duration)	-91.192	11.624	-.429**
Perceived(Coach Encouragement)	-71.241	72.350	-.064
Perceived(Systemic Coaching)	162.724	84.942	.142
Perceived(Scientific Coaching)	-33.778	66.474	-.034
Perceived(Parental Support)	-62.497	52.559	-.067
Motivation(Higher Education)	104.982	57.039	.114
Motivation(Life Career)	-111.632	51.707	-.126*
Peer Influence	82.593	51.441	.088
Voluntary Interest	-67.751	72.643	-.064
Self_Dedication	-115.862	82.067	-.101
Media Effect	24.732	50.035	.028
Perceived(Physical Advantage)	78.647	59.030	.074
Perceived(Mental Advantage)	-33.418	59.852	-.034
R^2	.382		
Adjusted R^2	.341		
F	9.297**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

Table 2. Summary of Multiple Regression TWO (N = 192)

Variable	*B*	*SE B*	*β*
(Constant)	3868.056	455.508	
Gender	-737.709	120.694	-.381**
Sampling	-164.738	130.205	-.078
Specialization(Type)	-468.744	167.676	-.238**
Specialization(Critical Period relative)	-99.414	122.741	-.049
Specialization(Gap)	-135.726	17.563	-.510**
Specialization(Duration)	160.864	155.960	.084
Perceived(Coach Encouragement)	-62.264	90.499	-.058
Perceived(Systemic Coaching)	-37.440	108.814	-.032
Perceived(Scientific Coaching)	58.685	79.594	.063
Perceived(Parental Support)	-48.521	69.828	-.049
Motivation(Higher Education)	57.095	70.728	.061
Motivation(Life Career)	-141.914	62.622	-.159*
Peer Influence	68.209	62.636	.073
Voluntary Interest	-33.991	86.424	-.033
Self_Dedication	-64.276	96.891	-.058
Media Effect	.357	62.482	.000
Perceived(Physical Advantage)	113.567	73.465	.106
Perceived(Mental Advantage)	-73.056	75.556	-.074
National-level appearance (Elementary division)	-107.052	203.245	-.053
National-level appearance (Elementary division_Final round)	122.024	209.716	.054
R2	.427		
Adjusted R2	.360		
F	6.374**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

Table 3. Summary of Multiple Regression THREE(M) (N = 110 Men)

Variable	*B*	*SE B*	*β*
(Constant)	2115.195	490.651	
Sampling	-320.818	137.382	-.217*
Specialization(Type)	-42.416	196.200	-.028
Specialization(Critical Period relative)	-99.264	168.637	-.071
Specialization(Gap)	106.405	132.269	.074
Specialization(Duration)	-90.281	20.593	-.435**
Perceived(Coach Encouragement)	25.620	89.561	.034
Perceived(Systemic Coaching)	-207.036	114.974	-.254
Perceived(Scientific Coaching)	188.701	84.478	.278*
Perceived(Parental Support)	-38.751	69.956	-.057
Motivation(Higher Education)	143.022	69.181	.218*
Motivation(Life Career)	-165.395	64.811	-.275*
Peer Influence	54.202	66.319	.079
Voluntary Interest	10.971	89.541	.015
Self_Dedication	13.460	101.378	.017
Media Effect	17.434	61.883	.029
Perceived(Physical Advantage)	54.513	81.015	.068
Perceived(Mental Advantage)	-102.167	86.536	-.143
National-level appearance (Elementary division)	-503.706	237.670	-.327*
National-level appearance (Elementary division_Final round)	612.768	250.257	.351*
R2	.346		
Adjusted R2	.208		
F	2.503**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

Table 4. Summary of Multiple Regression THREE(F) (N = 82 Women)

Variable	*B*	*SE B*	*β*
(Constant)	4734.693	773.472	
Sampling	-6.699	244.912	-.003
Specialization(Type)	-823.090	282.092	-.375**
Specialization(Critical Period relative)	525.184	274.679	.229
Specialization(Gap)	-121.410	227.659	-.048
Specialization(Duration)	-181.269	28.949	-.638**
Perceived(Coach Encouragement)	-238.871	190.834	-.177
Perceived(Systemic Coaching)	337.210	214.198	.234
Perceived(Scientific Coaching)	-177.486	149.253	-.162
Perceived(Parental Support)	-36.577	144.203	-.029
Motivation(Higher Education)	-107.961	150.052	-.095
Motivation(Life Career)	-140.252	123.622	-.120
Peer Influence	225.832	124.551	.208
Voluntary Interest	-123.175	166.942	-.099
Self_Dedication	-143.425	172.839	-.105
Media Effect	-82.797	138.329	-.074
Perceived(Physical Advantage)	279.569	126.299	.232*
Perceived(Mental Advantage)	-101.959	124.037	-.090
National-level appearance (Elementary division)	77.406	333.791	.035
National-level appearance (Elementary division_Final round)	-144.345	330.410	-.060
R2	.576		
Adjusted R2	.446		
F	4.431**		

Dependent variable : Relative World Ranking

*p < .05. **p < .01.

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체육교육과

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본 연구는 한국의 스포츠인재개발 시스템의 효율성과 효과성을 탐색하기 위한 목적으로 수행되었다. 이를 위해 스포츠전문화, 스포츠인재개발시스템 등과 관련된 국/내외 문헌들을 고찰하여 연구의 이론적 배경으로 활용하였다. 그리고 이론적 배경을 토대로 스포츠 인재의 조기 발굴과 조기 전문화가 높은 경기력(국제경쟁력)을 가지고 있는 우수 선수를 효과적으로

육성하기 위한 전제조건이라는 결론을 도출하였다.

한국의 스포츠인재개발 시스템의 효율성과 효과성 탐색을 위한 연구 대상으로 정부와 대기업의 광범위하고 지속적인 지원에도 불구하고 상대적으로 두드러진 성과를 창출하지 못하고 있는 것으로 평가되는 '육상' 종목을 선정하였다.

연구의 목적을 달성하기 위해 설정한 연구 문제는 다음과 같다.

1. 스포츠 인재의 조기 발굴과 조기 전문화가 동 종목의 최고 경기력 달성을 위한 필수 요소인가?

2. 육상에서 상위 경기력을 보유하게 된 선수들의 특징은 무엇인가?

대한육상연맹의 선수 기록 데이터를 기반으로 기초 연구자료를 수집하고 구체적인 연구대상을 파악하였으며, 웹기반 설문조사를 통해 양적연구를 위한 주요 변인들을 수집하는 한편, 국제육상연맹에 등재된 선수 랭킹 자료 등을 활용하여 종속변인 설정을 진행하였다.

구체적으로 2000년에서 2018년까지 육상 단거리 종목별 (남자 100m, 200m, 400m / 여자 100m, 200m, 400m) 국내

상위 100위 이내의 선수 명단들을 교차 분석하여 총 399명의 설문 대상이 파악되었고, 설문진행 결과 294명(응답율:73.68%)의 연구대상이 설문조사에 참여하였으나, 종속변인 설정에 부합되지 않는 4명의 응답자를 분석대상에서 제외시킴에 따라 최종적으로 290명의 응답자료를 기반으로 통계적 처리를 진행하였다. 주요한 통계적 처리로는 연구 문제 1의 답을 도출하기 위한 상관관계 분석과 연구 문제 2의 답을 도출하기 위한 회귀분석이 진행되었고, 분석결과에 따른 추가적인 기술통계 분석도 진행되었다.

본 연구를 통해 다음과 같은 결과를 도출하였다. 첫째, 스포츠 인재의 조기 발굴 및 조기 전문화와 선수의 향후 경기력 간의 정적 상관관계를 발견할 수 없으며, 특히 남자의 경우에는 유의한 역상관 관계가 발견되었다. 둘째, 성공적인 육상 선수들은 한국의 스포츠인재개발모델이 추정하고 있는 시기보다 더 늦게 전문적인 훈련에 참가하는 것으로 파악되었다. 더불어, 여자의 경우에는 육상 전문화 전 기타 종목 참여 여부와 향후 경기력 간의 상관관계가 나타나지 않은 반면, 남자의 경우에는 사전 종목 참여가 향후 경기력과 유의한 정적 관계에 있는 것으로 나타났다.

셋째, 엘리트 선수 양성을 위해 도입된 제도적 도구가 높은 수준의 선수 양성에 활용되기 보다는 특혜를 취득하기 위한 수단으로써 활용되고 있는 것으로 파악된다. 특히, 남자의 경우에는 군면제 특혜에 대한 동기와 향후 경기력 간에 유의한 관계가 나타나지 않았고, 상급학교 진학 특혜에 대한 동기와 향후 경기력 간에는 유의한 부적 관계가 나타났다.

결론적으로, 한국의 스포츠인재개발 모델은 '육상' 종목에서 그 목표하는 바를 효율적이고 효과적으로 달성하지 못하고 있다고 평가할 수 있다. 따라서, 천편일률적으로 모든 종목에 적용하는 스포츠인재개발 모델을 넘어서, 육상 종목을 포함하여 각 스포츠 종목의 특성을 고려한 차별화된 접근법이 요구된다.

주요어 : 스포츠 전문화, 조기전문화, 장기선수육성, 학생선수, 엘리트 스포츠시스템, 한국 육상, 스포츠인재양성

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